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Identification of Regional Sediment Management (RSM) Opportunities Along the Upper Texas Coast Through Sediment Budget Analysis

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PURPOSE. The purpose of this Coastal and Hydraulics Engineering Technical Note (CHETN) is to document development of a regional sediment budget and assessment of coastal sediment needs on the Upper Texas Coast from the Sabine Pass to the Matagorda Ship Channel. This effort was undertaken to better communicate regional sediment processes and assess Regional Sediment Management (RSM) opportunities along the Texas coast.

INTRODUCTION. RSM opportunities are driven by the ability to link sediment sources (places with excess sediment) and sediment sinks (places that need sediment). One impediment to successful RSM has been the need to efficiently share knowledge of these sources and sinks in a manner that facilitates collaboration between projects within the US Army Corps of Engineers (USACE) as well as between USACE and non-Federal project sponsors. This study, supported by the USACE RSM program, presents a first step in improving communication of that knowledge. Specifically, the study aims to:

- Graphically display sediment transport processes in a way that is easily understood,
- Graphically display projects or sites that have future sediment needs, and
- Facilitate communication to identify and capitalize on RSM opportunities.

To demonstrate the concept, this study is limited to beaches and inlets. If the results justify future investment, the database can be expanded to include inland project data as well as engineering activities.

The Sediment Budget Analysis System (SBAS) software for ArcGIS®10 toolbar (Rosati and Kraus 2001; Dopsovic, Hardegree, and Rosati 2002) was applied to compile existing sediment budgets for the Upper Texas Coast from the Sabine Pass to the Matagorda Ship Channel into a single budget that can be easily appended. The sediment budget is an intuitive way to organize, process, and display sediment transport processes. Sediment budgets are directly useful in identifying future project needs by showing where sediment accumulates and erodes. The sediment budget is stored in a shapefile or geo-database format. The second step was to identify potential projects or sites within the region that may need sediment. The list developed is not all inclusive and is intended to be shared with USACE partners for constructive input. Both data sets reside in the US Army Engineer District, Galveston (SWG) enterprise Geographic Information System (eGIS) database. Making processes and sediment needs available together in the same format to everyone should help to identify new RSM opportunities.

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COMPILE EXISTING PROJECT LEVEL (LOCAL) STUDIES INTO ONE REGIONAL SEDIMENT BUDGET. Three project level (local) sediment transport studies had already been conducted for: (1) the Sabine Pass to the San Luis Pass (King 2007, Morang 2006), (2) the San Bernard River to the Matagorda Ship Channel (Thomas and Dunkin 2012), and (3) the area east of the Matagorda Ship Channel to immediately west of the channel (Rosati *et al.* 2011). The SBAS PC-based computer tool (Rosati and Kraus 2001) was used to combine these three studies to develop a regional characterization of coastal (including beaches and inlets) sediment transport rates and magnitudes for the overall coastal region extending between the Sabine Pass and the Pass Cavallo. Results from the analysis are graphically represented in the form of sediment budget cells (Figure 1). This task also helped to establish locations where there are data gaps within the region.

This work used the SBAS Sediment Budget Tool, previous applications of the Genesis model (a shoreline change model designed for project scale engineering studies) (Hanson 1989, Hanson and Kraus 1989, Gravens *et al.* 1991), and Texas Shoreline Change Project data (Gibeaut *et al.* 2000). The final product from this task is a sediment budget with cells and lines representing littoral cells and transport fluxes derived from the regional sediment budget analysis. The data were output into shapefiles and were made available on the SWG website. The data were also populated into the SWG eGIS, which is also referred to as the Navigation and Coastal Databank (NCDB), currently under development.



Figure 1. Upper Texas Coast regional sediment budget cells from Sabine Pass to the Matagorda Ship Channel, TX.

Figure 2, which shows an enlarged view of the sediment budget cells from Sabine Pass to Rollover Pass, gives an example of data included in the sediment budget. The alongshore length of each cell marks the approximate limits of cell boundaries, such as structures or inlets. However, the cross-shore dimension is not significant. For most coastal cells, the beach and shallow near-shore areas are treated as a unit, although one could have separate cells for beach, near-shore, and open water. The arrows show flux rates in units of m^3/year . Delta V (ΔV) represents volume change with negative values in beach cells indicating erosion and positive values indicating accretion. Placement or removal of sediment is included within the cells where needed, typically as a result of beach nourishment or dredging.

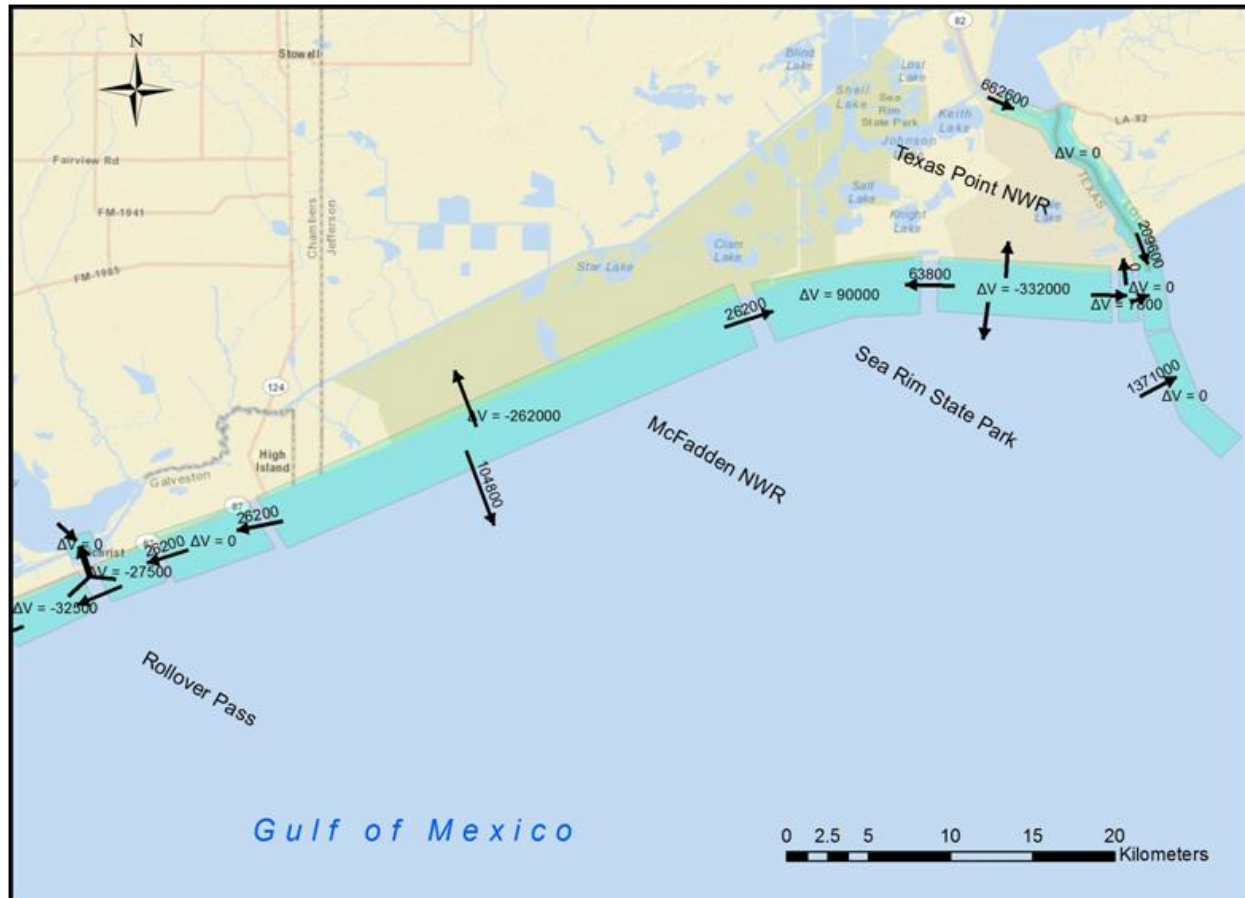


Figure 2. Sediment budget from Sabine Pass to Rollover Pass, TX (volumes in m^3/year).

This SBAS study identified additional analyses that should be conducted:

1. Compute flood shoal volume changes in San Luis Pass.
2. Compute dredging volumes and locations of sediment removal in Freeport entrance channel, and determine quantity in these volumes that was sediment from open coast.
3. Re-evaluate southern cells to remove residuals. Are there other sediment sources or sinks?
4. Optional: re-examine Galveston Channel dredging following the recent channel deepening.
5. Continue developing the sediment budget further southwest along the Texas coast.

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6. Ascertain if sediment from the offshore disposal area south of Galveston entrance is moving onshore.
7. Evaluate material entering Galveston Channel in the Big Reef area.
8. Compute the volume of wind-blown sand at East Beach and Matagorda regions.

GATHER ADDITIONAL INFORMATION AND DATA AS REQUIRED. Existing information and data were used to improve understanding of regional sediment transport and historical management practices. Existing information and data from previous field surveys and investigations, including dredging and dredge material placement activities, were gathered through research of existing files, records, and SWG database systems. These data, in combination with interviews with SWG operations managers, engineers, and planners, as well as with state resource agencies, potential stakeholders, and contractors, were all used in performing this sediment budget analysis. Information that did not serve as raw data in this sediment budget analysis was graphically represented in shapefile format, showing locations where excess sediment could be produced or used. Information regarding areas in which there is a need for sediment was also gathered from various sources, including the Sabine Pass to Galveston Bay Feasibility Study public meetings and other USACE sponsor input. Locations where sediment may be needed were added to the database.

PROPOSED APPLICATION. RSM is best accomplished by following a standard process of first identifying challenges, then understanding the physical processes involved, and finally working across projects to find mutually beneficial solutions. This study has developed tools to visualize and communicate physical processes in an easy to understand format (sediment budget), and has begun to identify other opportunities for RSM along the Texas coast. By making this information readily available to USACE and its partners, new opportunities for managing sediment will be identified and better formats for communicating about RSM will be developed.

As an example, Figure 3 shows information in the database near the Galveston Entrance Channel. The sediment budget cells are color coded to represent degrees of erosion or accretion within the cell. Arrows indicate direction of net transport (or flux) at cell boundaries. Stars and lines indicate locations or areas where projects that could use additional sediment are located. A description of each project is available by selecting each of the stars or lines. The example shows that, by visual inspection of the sediment budget, it is possible to see that excess sediment accretes on both sides of the jetties. Then sediment is transported through the jetties into the entrance channel. Inspection of the adjacent projects reveals that sediment is desperately needed on the Galveston Island beaches to the southwest of the jetties and to the northeast near Rollover Pass. Inspection of the projects reveals that local and state agencies have a need for sediment that USACE is dredging. It also shows that an ongoing feasibility study has multiple potential uses for USACE dredged material. The graphics also make a compelling case for evaluating the jetties' efficiency at keeping sand out of the navigation channel.

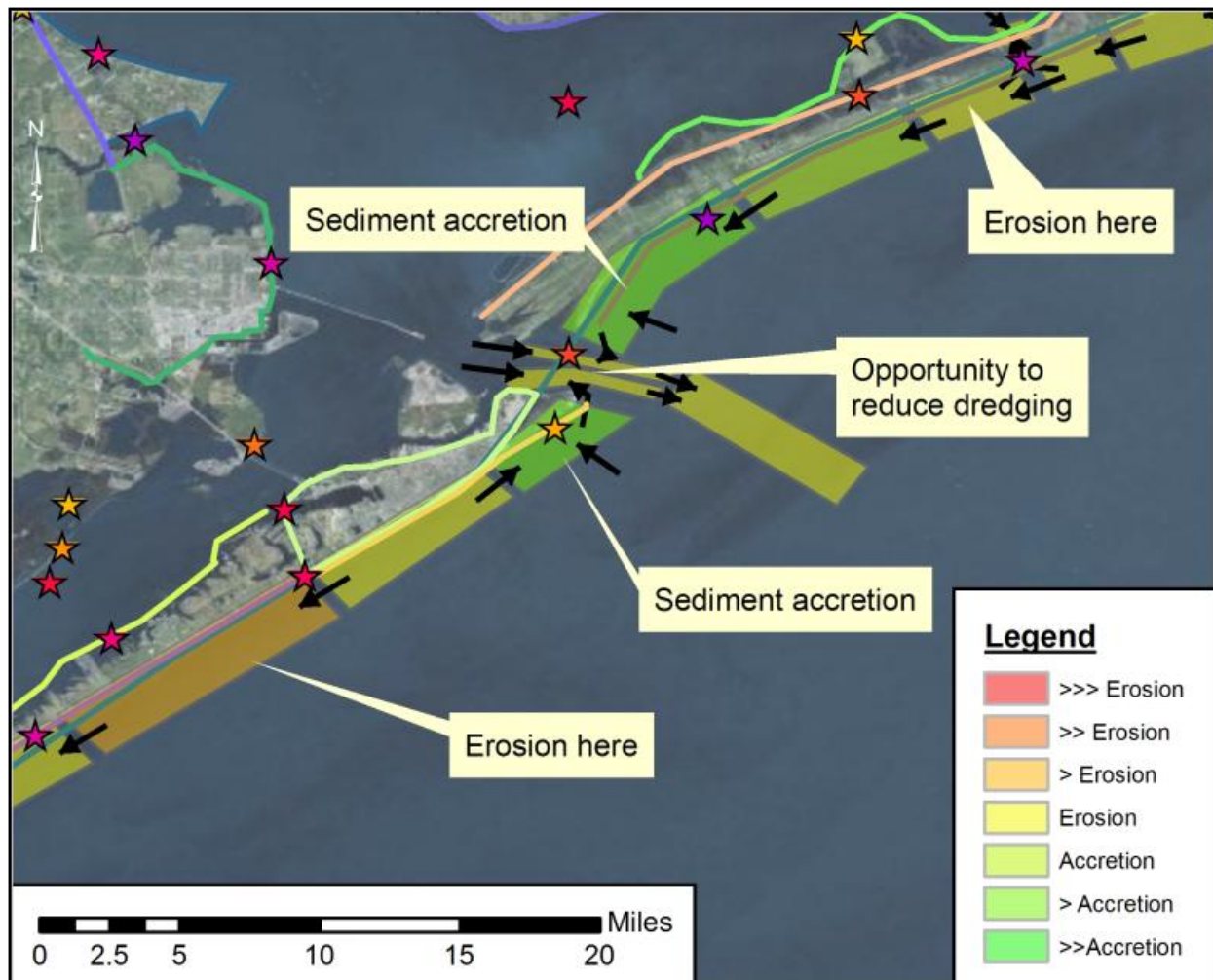


Figure 3. Sediment budget and potential projects that need sediment near Galveston, TX.

While this kind of information previously existed, it was heavily dependent on individual expertise and networking. Once provided in an open and easily modified format, the data will more clearly show the benefits of RSM and will be more accessible to USACE personnel and partners, who will include RSM concepts in project design and implementation. Ultimately, more partners will consider USACE dredged material as a resource for their projects.

CONCLUSIONS. This work is intended to improve RSM communication both within SWG and between SWG and its many partners. The overall goal is to develop a comprehensive framework for RSM in Texas. The framework will be displayed in a Geographic Information System (GIS) format that will represent the current understanding of coastal processes along the Texas coast, current SWG practices and policies, and both Federal and non-Federal RSM needs and desires. The result will be the ability to display processes, practices, and needs through a single interface, thus making it easier for managers, planners, and engineers to include RSM in coastal projects. It will also be a way to inform sponsors, partners, and agencies of sources and quantities of materials that they can use in the future for their own projects. As additional sediment budget information is developed along the Upper Texas Coast, the results can be

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uploaded into these files to continue to document sediment sources for use in future coastal projects. This project has completed the first step in a long process of improving RSM communication in Texas. Future efforts will include presenting the results at SWG beneficial use meetings and displaying the information on the SWG geospatial portal.

ADDITIONAL INFORMATION. This Coastal and Hydraulics Engineering Technical Note (CHETN) was prepared as part of the Regional Sediment Management (RSM) program. This CHETN was written by Sheridan Willey, Tricia Campbell, and Samantha Lambert of the US Army Engineer District, Galveston, TX; and Dr. Andrew Morang, Dr. David King, and Robert Thomas, US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory (ERDC-CHL), Vicksburg, MS. This document can be accessed on the Galveston District website: <http://www.swg.usace.army.mil/Home.aspx>

Additional information pertaining to the Regional Sediment Management program may be found at the RSM web site: <http://rsm.usace.army.mil>

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ACRONYMS AND ABBREVIATIONS.

| Term | Definition |
|-------------|---|
| CHETN | Coastal and Hydraulics Engineering Technical Note |
| CHL | Coastal and Hydraulics Laboratory |
| ERDC | Engineer Research and Development Center |
| GIS | Geographic Information System |
| NCDB | Navigation and Coastal Databank |
| PC | Personal Computer |
| POC | Point of Contact |
| RSM | Regional Sediment Management |
| SBAS | Sediment Budget Analysis System |
| SWG | US Army Engineer District, Galveston |
| US | United States |
| USACE | US Army Corps of Engineers |

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